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A DESIGN FOR OBSERVER SAMPLING OF MEMBER INTERACTION IN A LARGE--ETC(U)
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Some social psychological problems require data on frequency of interaction. In a large (greater than 20 persons) spontaneous group this raises methodological problems of great complexity. A technique used for sampling interaction by observers of such a large, spontaneous group is described. The technique was based on estimates made by Larntz (Appendix 3.1) of size of the counts necessary to infer the existence of informal groups from a large matrix of such counts.

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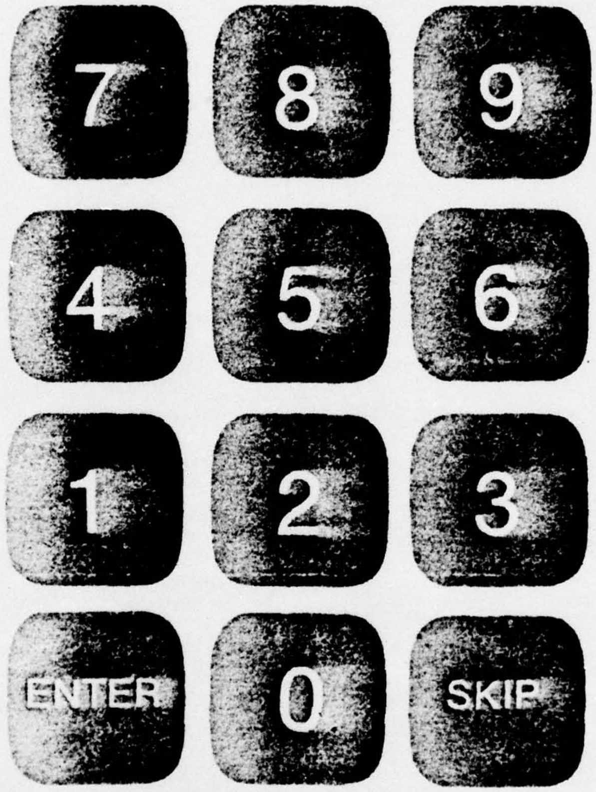

Observations

TITLE A DESIGN FOR OBSERVER SAMPLING OF MEMBER INTERACTION IN A LARGE, SPONTANEOUS GROUP

AUTHOR Richard E. Sykes, Ph.D.

SERIES NUMBER TR #3

OBSERVATIONAL RESEARCH

MINNESOTA SYSTEMS RESEARCH, INC.
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TR #3--February 17, 1977

A DESIGN FOR OBSERVER SAMPLING OF MEMBER INTERACTION IN A LARGE, SPONTANEOUS GROUP [1]

by

Richard E. Sykes, Ph.D.

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INTRODUCTION

Social psychological research problems sometimes require collection of data on intragroup communication. The investigator must know who talked to whom and how frequently. Two factors which have the potential for complicating the collection of such data are group size and type of communication pattern. Chapple, Bales and many others have collected such data, but usually in groups either so small or so orderly that one observer could monitor the entire group simultaneously.

If subjects are to be identified individually, then size is an important constraint. The observer must quickly be able to identify every subject individually. The larger the group, the more difficult it is to do this. No doubt there is some upper limit on size (so far as I know, unknown) for ready identification by the average observer. Size also effects geographical area. Larger groups require a larger area and constrain visual recognition across distances.

Even more important than size is communication pattern. For instance, a very large lecture class can be observed so long as the lecturer is the focus of communication. The lecturer's communicative acts and those addressed to him by auditors can be coded without great difficulty. When such a pattern breaks down and spontaneous, simultaneous dialogue begins within many dyads most category systems interpret this as a manifestation of disorder and provide a residual category to describe it such as "silence or confusion" (Flanders, 1970, 34).

There are many natural groups in which spontaneous, simultaneous communication within many dyads is not only normal but a manifestation of order, not disorder. In a large office many separate conversations occur simultaneously. This is also true of a party. Whatever the group or situation, multiple dyadic interaction requires the observer to adopt a different stragegy of data collection than is used in small groups or groups with a centralized communication pattern.

THE PROBLEM IN THE NAVY STUDY

The focus of the Navy study was the influence of proximity and similarity on informal group formation. As in the Sherif studies I wished to study the emergence of informal groups in a natural setting. It was necessary to record the frequency of interaction of individuals as these smaller, informal groups differentiated within a larger one, and be able to document the emergence of patterns. One way to do this was to observe subjects in training units varying in size from 30 to 60 men interacting spontaneously and simultaneously in the compartment (barracks wing) in which they lived.

Figure 1 is a sketch of a typical compartment of such a unit. The men were assigned to double racks (bunks) (for typical examples see Figures 2-7). Each compartment held a maximum of 80 men in 40 racks. In addition to the main compartment itself, there was a small office and entrance hallway to the fore. Aft, the compartment connected to a lounge where men could view TV or use pop machines. At the fore of the compartment, on the starboard side, were doors leading to the head, showers and drying room. Each unit spent free time from 1530 until taps

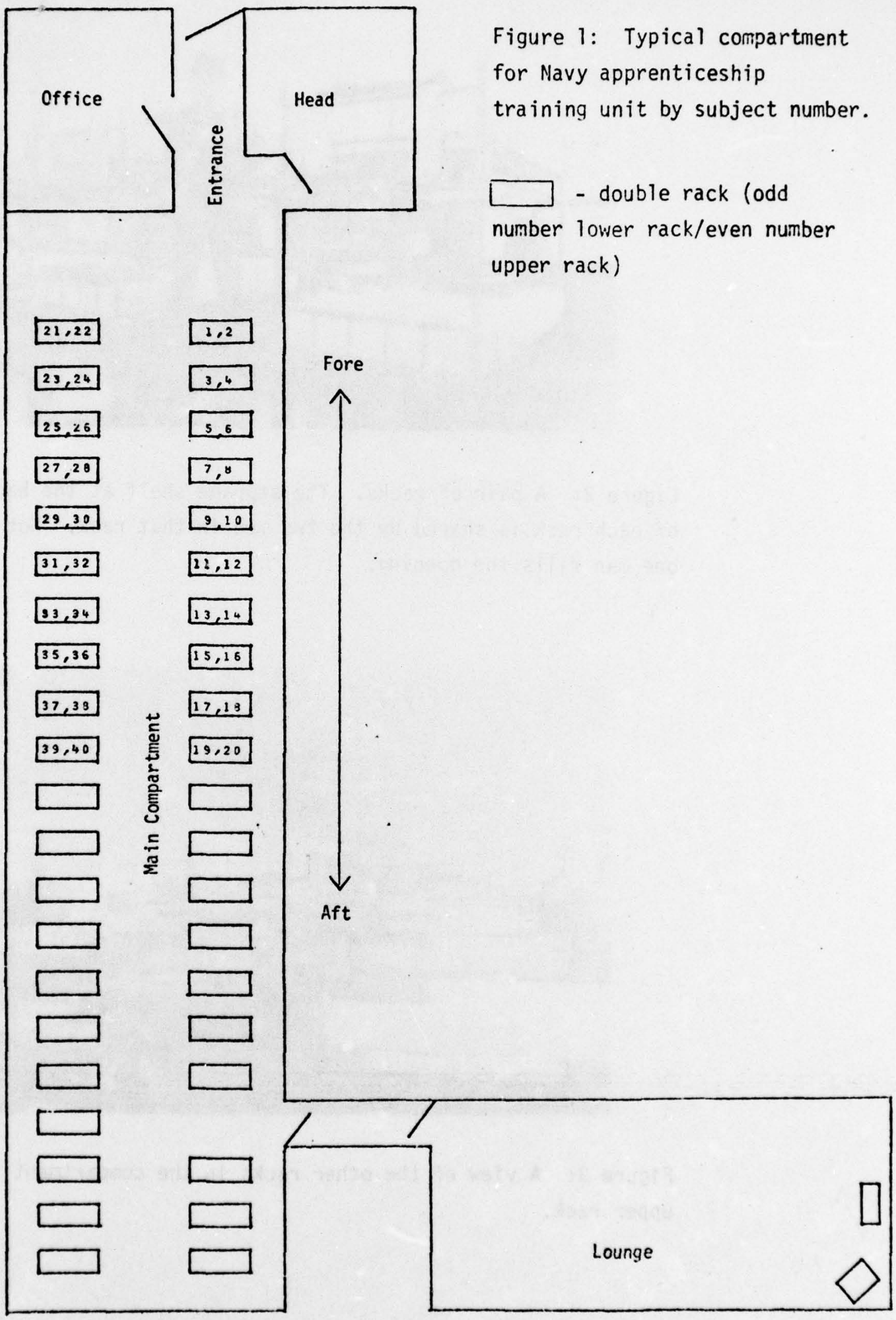

Figure 1: Typical compartment for Navy apprenticeship training unit by subject number.

▭ - double rack (odd number lower rack/even number upper rack)

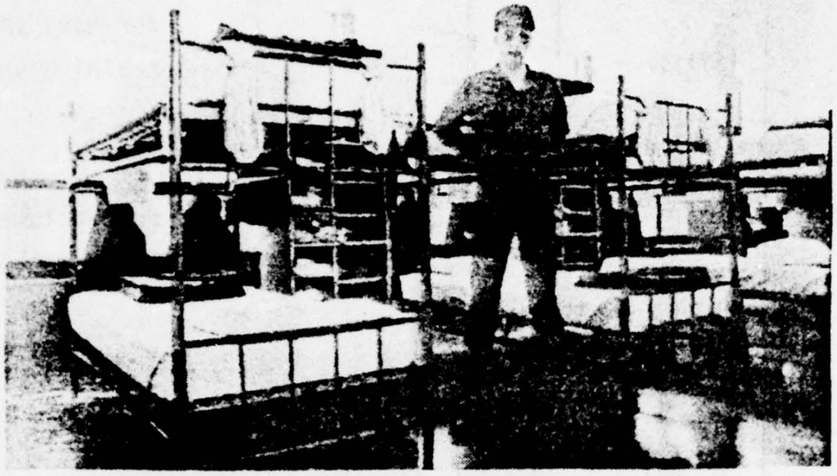

Figure 2: A pair of racks. The storage shelf at the back left of each rack is shared by the two men in that rack. Notice that one man fills the opening.

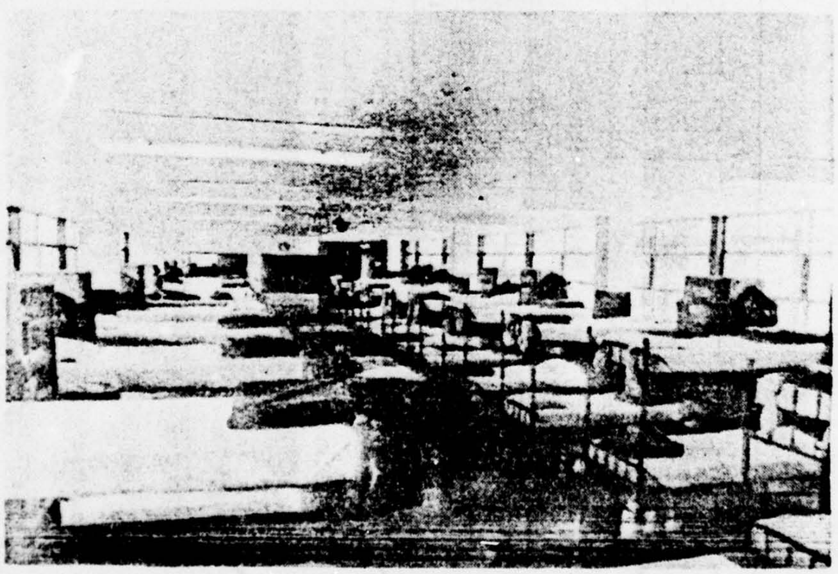

Figure 3: A view of the other racks in the compartment from an upper rack.

Figure 4: A perspective down the center of the compartment. Notice the tables where men may read, write, play cards (contrary to regulations) or sew.

Figure 5: A side view of the compartment from the perspective of an upper rack. This is a typical view of observers when collecting interaction data.

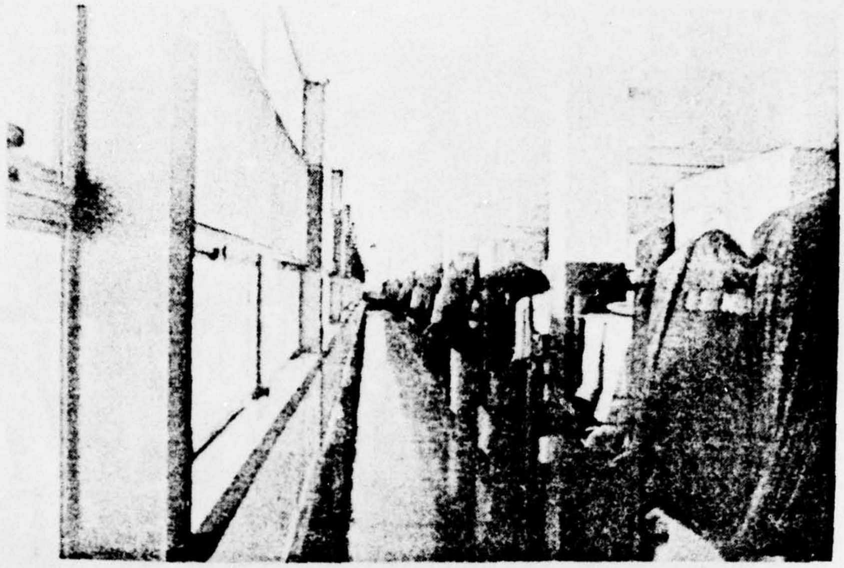

Figure 6: The passageway along the starboard bulkhead. Most observations were taken from the vantage of this relatively inconspicuous and little-used location.

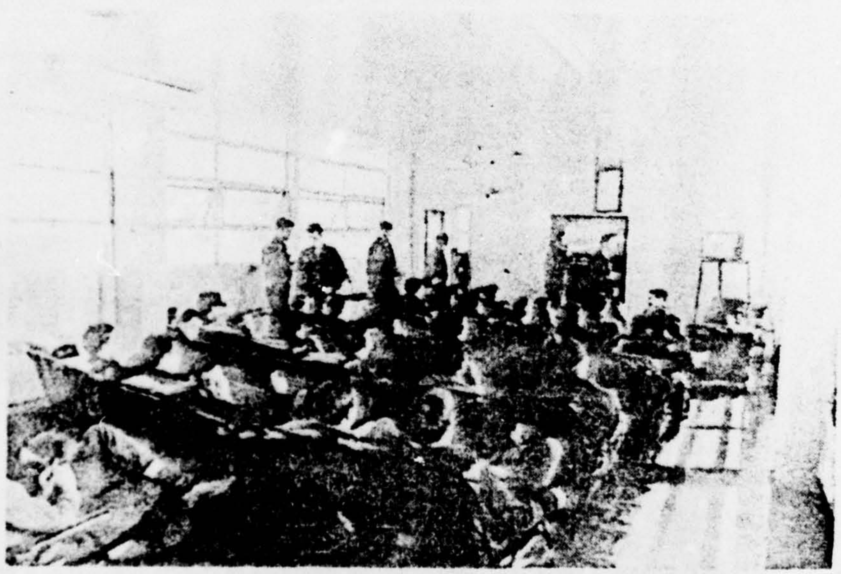

Figure 7: The smoking and television lounge attached to the compartment. Notice the television set and Coke machine, the foci of activities. Many units spent well over a quarter of their free time watching television.

(2130) within this area. Interaction patterns developed within a new training unit during their free time. Interaction was usually spontaneous and simultaneous among several different groups of trainees.

Because of their number, physical location and the decentralized communication pattern it was not possible to observe all the men simultaneously. It was necessary to develop a sampling design based on a knowledge of the size of sample necessary for analysis and inference as estimated by Larntz (see the other paper included with this report). For reasons stated below it seemed important to collect data on interpersonal communication within other areas of the training battalion including the galley, classroom and classroom lounge (see Figures 8-9) where interaction was also simultaneous and spontaneous. Here too, it was necessary to develop a sampling design.

SAMPLING THE COMPARTMENT

In developing the design, consideration was given to several alternatives. In a previous study six subjects in a group of 80 had been sampled on an ordered, rotation basis. Using a list of the six, the observer had located the first subject on the list and recorded his communicative behavior at the time located, then the second, and so on. When the sixth subject was coded the observer started again at the beginning of the list. All six were coded within a time limit. This method entailed successive search within a geographical area containing several rooms, one of which was about 160 feet long and contained many people. Finding six subjects was very time consuming. Successively locating an entire unit would have been even more time consuming and would have limited the total number of samples to a small number. Any method involving search for individuals was impractical.

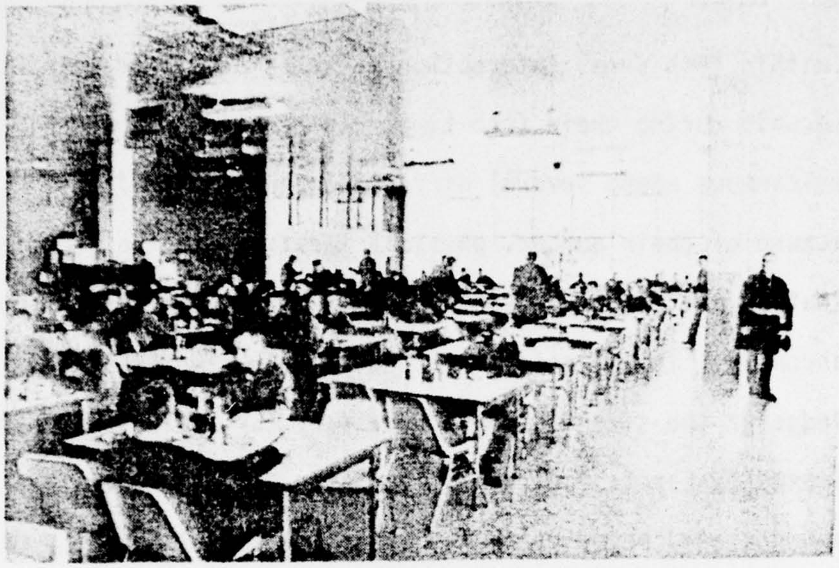

Figure 8: The galley where apprentices ate their meals. They seated themselves at vacancies at these tables after going through a cafeteria line. The unit marched to the galley as a group.

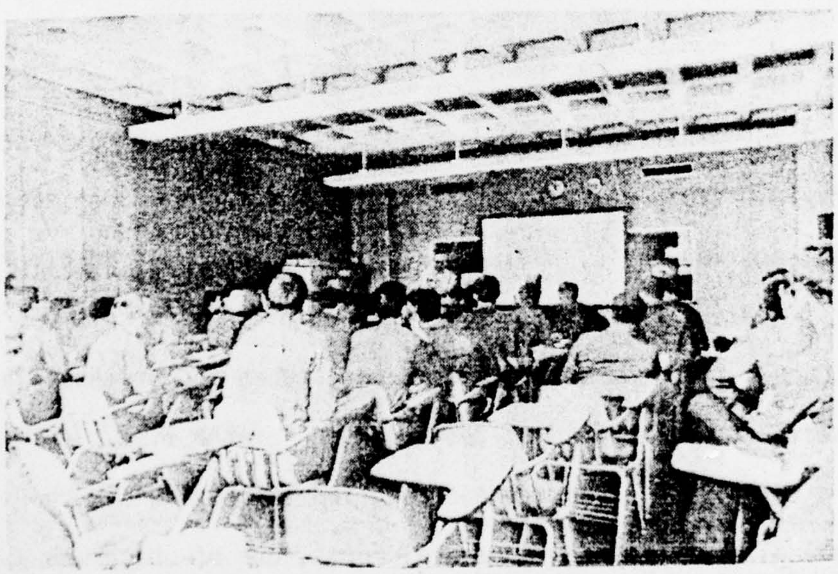

Figure 9: One of the classrooms. Each unit was in training for ten curriculum days.

The alternative we choose was a form of area sampling. The compartment and lounge were divided into ten sampling areas (see Figure 10). Each area was delimited, based on pretesting, considering as a criteria what size geographical area could normally be quickly scanned by an observer to determine: a) who was in the area; b) if someone was in the area, whether interaction was occuring; and c) if interaction was occuring, then with whom?

It was not practical to divide the area into units of equal size. Certain large areas were seldom used, while some small areas were intensively used. In Figure 10 the numbered sampling areas are displayed. Dividing lines between areas went through the center of racks. This may at first seem surprising, but is due to the fact that pretests showed that subjects lying flat on their backs in the middle of racks seldom interacted. They were more apt to sit up on one side of the rack or the other when talking to another subject.

One study unit occupied about half the racks in the compartment. All the racks in Area Seven were unoccupied. While subjects occasionally used this area, activity was not great considering its size. Similarly Area One was larger, including the entrance passageway and a small office. Much interaction took place in the equally-sized Area Two through Six. By walking down the starboard isle next to the bulkhead the observer could inspect one sampling area at a glance. He then coded the area: a) empty of subjects; or b) if occupied he identified the occupants and whether or not they were interacting; and c) if they were interacting he coded the interaction partner(s).

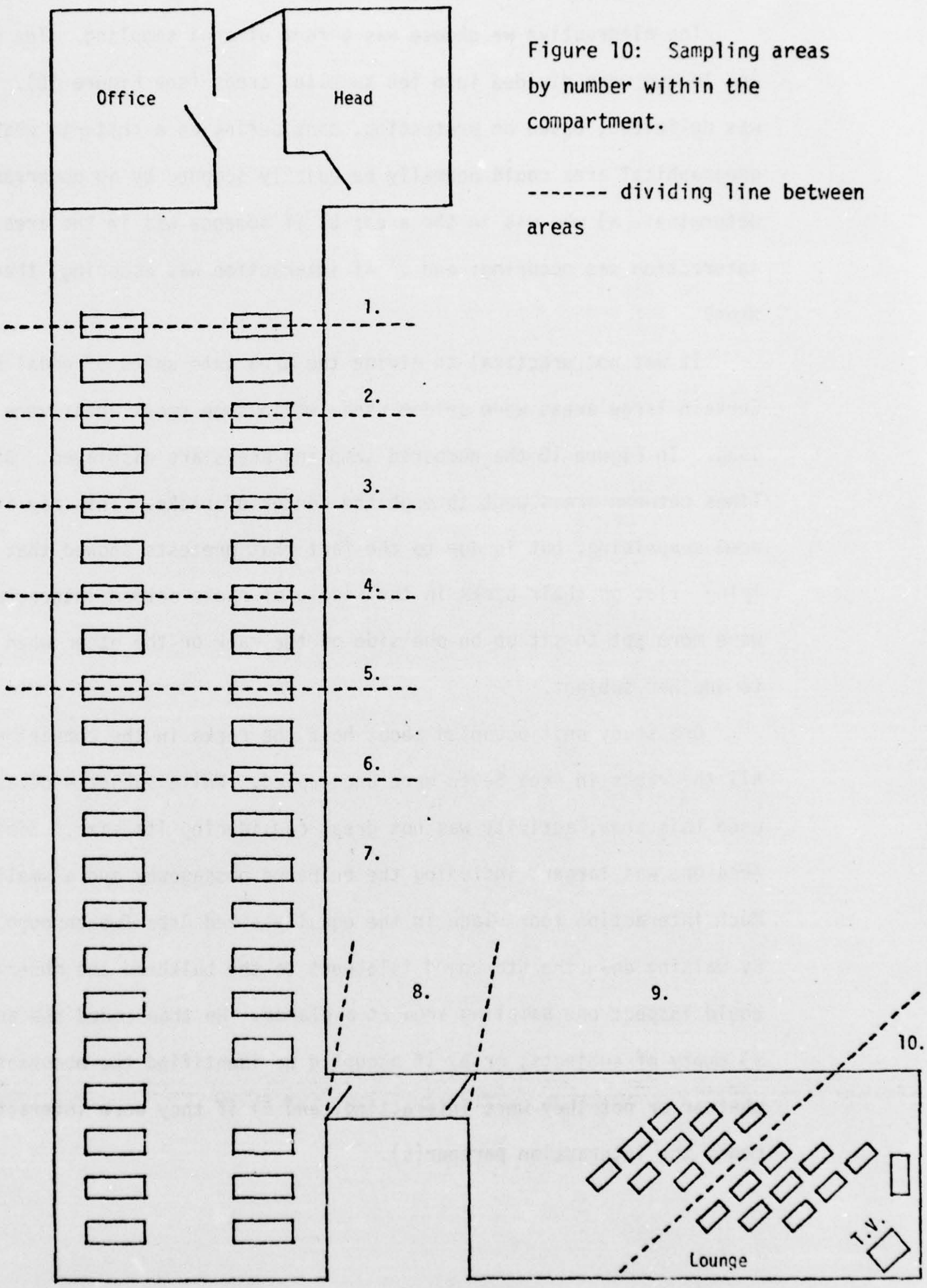

Figure 10: Sampling areas by number within the compartment.

------- dividing line between areas

The hallway into the lounge was considered a sampling area (Area 8). The lounge was divided into two areas. The chairs were lined up in several rows facing the television, which was mounted in a corner. A more or less diagonal line divided rows of chairs closest to the television from rows in the back. One sampling area in the lounge included that part of the area close to the television; the other that part which was more distant. While these two areas were often crowded the attention of the subjects was usually focused on the television. This focus effectively constrained interaction so that the observer could readily code for each area.

After the areas were delimited random lists (without replacement) of the ten areas were generated. After pretesting it was found that it was possible to sample all ten areas in 15 minutes. The observers were instructed to sample the ten areas in random order for 15 minutes. They would then sample the ten areas the next 15 minutes using a different random order. Sampling was carried out each weekday from 1530 to 2130 on the 15 minute schedule with a half hour break for chow. It was possible to get from 18 to 22 samples per day using this schedule.

It was necessary to enunciate several conventions for observers to follow in utilizing this design. The first convention pertained to those lying in the middle of their racks and therefore in the middle of the imaginary line dividing sampling areas. Such a person was always considered to be in the area aft of the dividing line. Thus, a person lying in the middle of the first rack was considered to be in area two.

The second convention pertained to interarea interaction. For obvious reasons it was necessary to avoid counting a subject twice, if for instance, two subjects were conversing across the boundary of an area. Since both

speaker and listener were coded it would have been possible to code both present in each area, thus compromising the independence of each count. To avoid this, when interarea interaction was occuring it was coded only if the other subject was to the aft of the area being coded. Thus, if subject A in Area Two talked to subject B in Area Three, when Area Two was sampled the interaction would be toward the aft and therefore coded. When Area Three was sampled, since the same dyad would be interacting toward the fore it was not counted. Counting the same interaction twice was thus avoided with this procedure.

Finally, by convention (or definition) we utilized a somewhat broader definition of "interaction" than many have used. Often "interaction" is limited to focused verbal behavior. There are several other essentially symbolic activities which are focused, but which may not involve continuous overt verbal behavior. In the first place interacting includes not just talking, but active listening. Since the observer scanned an area, taking a fix on its occupants and whether or not they were interacting, he did not listen to a sequence of turn taking in conversation. The observation of each area was somewhat like a snapshot, recording interaction as of that moment. Therefore, listening was considered as important as speaking. The first code indicated the speaker. The subsequent code specified the active listener(s).

Secondly, mutually focused symbolic activities in which two or more engaged such as playing cards or craps were considered to be interaction. Purely audience-type activities were not considered interaction. To qualify as interaction there had to be mutual participation in some common focus of interest which involved active participation by the subjects. Since, in this context, this unit was not a work group, this enabled us to code quite important forms of leisure interaction not limited to overt verbal behavior.

In Figure 11 is a printout from one observation period. Figure 12 is the matrix of counts from a full observation. The cells on the diagonal indicate the number of times the subject was coded as physically present in the compartment in some sampling area but not interacting. The off diagonal cells indicate the interaction counts with other subjects. Only the upper right triangular matrix is necessary because speaking is counted equivalent to listening. The count is symmetric. Marginals may be unequal for several reasons, not only due to normal sample variation, or observer error but due to subject absence from the compartment. For obvious reasons of privacy the head, shower and drying room areas were off limits to the observers. Subjects might also be on liberty during at least part of the period of observation (see "Liberty Sections" below) or occasionally, somewhere else in the barracks.

It was possible for the observer to code a subject twice during a 15 minute sampling period if the subject physically moved from one area to another during that time. The second coding indicated a different conversation from that coded in the first area, and therefore was at least partially independent of the first.

CLASSROOM SAMPLING

In every day life as one sequentially occupies one position after another - family member, student, employee, customer - one moves from one set of proxemic relations to another. Most studies have taken only one set of such relations

Figure 11:

An example of a data printout
from three sampling periods in the
compartment (see text under CODE for explanation)

```
      00100 HHH,0000,
      00110 040576,0019,
1.    00120 1532,0024,
      00130 CFH,0047,
2.    00140 1533,0061,
3.    00150 95*115*21,
4.    00160 C2,1621,
      00170 H22,1625,
      00180 12,1629,
4.    00190 C7,1710,
      00200 F17,1715,
      00210 C8,1760,
      00220 F29,1765,
4.    00230 C3,1881,
      00240 F11,1884,
      00250 14,1887,
      00260 12,1889,
      00270 H28,1894,
      00280 22,1897,
      00290 33,1901,
4.    00300 C4,1964,
      00310 H30,1969,
      00320 5,1971,
      00330 F12,1974,
      00340 33,1977,
4.    00350 C1,2033,
      00360 F20,2037,
      00370 24,2040,
      00380 23,2042,
      00390 1,2044,
4.    00400 C9,2225,
      00410 H29,2229,
      00420 27,2233,
      00430 F19,2236,
      00440 F13,2241,
4.    00450 C6,2330,
      00460 F31,2333,
4.    00470 C5,2385,
      00480 F14,2389,
4.    00490 C10,2619,
      00500 F29,2624,
      00510 F17,2627,
      00520 18,2630,
      00530 F6,2632,
      00540 2,2635,
      00550 F16,2641,
      00560 9,2643,
      00570 H7,2647,
      00580 10,2649,
      00590 21,2651,
      00600 F4,2654,
      00610 F25,2656,
5.    00620 CCC,2659,
      00630 1559,2665,
3.    00640 CFH,2734,
      00650 1600,2738,
      00660 95*116*21,
4.    00670 C7,2822,

      00680 F18,2826,
4.    00690 C1,2898,
      00700 H33,2902,
      00710 1,2904,
      00720 F14,2908,
      00730 H,2909,
      00740 27,2912,
4.    00750 C3,2983,
      00760 F8,2986,
      00770 14,2989,
      00780 24,2991,
      00790 22,2993,
      00800 26,2995,
      00810 12,2999,
4.    00820 C10,3165,
      00830 F17,3168,
      00840 21,3171,
      00850 F9,3173,
      00860 F16,3176,
      00870 31,3179,
      00880 F7,3182,
      00890 10,3185,
      00900 H85,3190,
      00910 32,3193,
      00920 F25,3197,
      00930 F4,3199,
4.    00940 C4,3281,
      00950 F100,3283,
4.    00960 C9,3389,
      00970 H19,3393,
      00980 27,3396,
      00990 F29,3400,
      01000 F23,3404,
      01010 H85,3407,
      01020 11,3410,
4.    01030 C6,3512,
      01040 F100,3515,
4.    01050 C5,3619,
      01060 F12,3622,
      01070 10,3625,
      01080 30,3628,
      01090 14,3632,
      01100 18,3641,
4.    01110 C2,3707,
      01120 F100,3709,
4.    01130 C8,3820,
      01140 F85,3823,
      01150 12,3826,
5.    01190 CCC,3888,
      01200 1612,3892,

3.    09540 CFH,3124,
      09550 2102,3129,
      09560 95*135*21,
4.    09570 C3,3297,
      09580 F17,3299,
4.    09590 C8,3367,
      09600 F100,3369,
4.    09610 C4,3449,
      09620 F13,3452,
      09630 H30,3455,
      09640 5,3457,
4.    09670 C9,3629,
      09680 F9,3633,
      09690 18,3636,
      09700 F13,3640,
4.    09710 C5,3713,
      09720 F32,3716,
4.    09730 C7,3752,
      09740 F23,3754,
4.    09750 C2,3815,
      09760 F3,3817,
4.    09770 C1,3864,
      09780 H22,3869,
      09790 2,3871,
      09800 F17,3875,
      09810 20,3878,
      09820 1,3879,
4.    09830 C10,4029,
      09840 F25,4034,
      09850 H85,4040,
      09860 29,4045,
      09870 F85,4052,
      09880 F6,4056,
      09890 F31,4063,
      09900 F33,4068,
      09910 24,4072,
      09920 19,4074,
4.    09930 C6,4140,
      09940 F14,4142,
5.    09960 CCC,4182,
      09970 2112,4184,
6.    10450 HFC,2652,
      10460 35*2015,2664,
      10470 28*2025,2675,
      10480 12*2015,2682,
      10490 28*1959,2691,
7.    10500 HFCHFC,2699,
      10510 ***,2703,
      10520 040676,2710,
      10530 2240,2715,
      10540 0000000
```

Figure 12:

A Matrix of Counts from a Full Observation

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	TOTALS	DIFF[1]
1	5	3	2	0	3	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	2	0	1	0	0	0	3	0	0	0	0	0	2	25	20
2		6	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	5	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	26	20
3			9	3	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	17	8
4				16	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	25	9
5					6	2	0	0	0	4	0	0	0	0	1	0	1	1	3	0	1	1	2	1	1	0	2	1	0	5	0	0	1	0	0	0	0	0	2	41	35
6						23	0	0	0	0	0	0	0	0	1	0	0	0	4	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	13
7							11	1	1	1	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	7
8								18	1	1	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	27	9
9									18	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	3
10										4	1	1	0	1	0	0	1	0	0	0	3	2	0	2	0	1	1	0	0	6	1	0	0	0	0	0	0	0	3	34	30
11											3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	4	13	10
12												10	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0	1	21	11
13													17	0	0	1	0	1	1	0	0	0	0	0	1	0	0	0	2	0	0	1	0	0	0	0	0	0	1	25	8
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16																12	0	5	3	0	0	0	1	0	0	2	1	0	0	0	3	0	2	0	0	0	0	0	0	32	20
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19																			10	0	0	1	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	32	22
20																				12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	6
21																					12	1	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	31	19
22																						11	0	6	0	0	1	2	0	1	0	0	1	0	0	0	0	0	0	30	19
23																							13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	11
24																								7	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	25	18
25																									11	0	1	0	2	0	0	1	0	0	0	0	0	0	3	20	9
26																										8	1	0	1	0	2	0	2	0	0	0	0	0	0	21	13
27																											8	0	1	1	1	0	2	0	0	0	0	0	1	32	24
28																												7	0	0	0	0	1	0	0	0	0	0	0	12	5
29																													10	0	0	2	0	0	0	0	0	0	7	27	17
30																														13	1	0	0	0	0	0	0	0	1	34	21
31																															12	0	2	0	0	0	0	0	1	29	17
32																																10	0	0	0	0	0	0	3	18	8
33																																	0	0	0	0	0	0	1	29	21
34																																		0	0	0	0	0	0	0	0
35																																			0	0	0	0	0	0	0
36																																				0	0	0	0	0	0
37																																					0	0	0	0	0
38																																						0	0	0	0
39																																							20	58	38

[1] Total less the count on the diagonal. Thus, DIFF is the number of interactions.

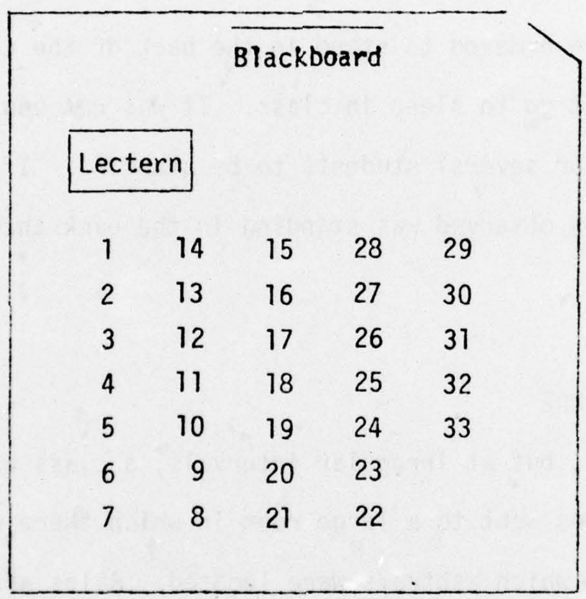
into account. For instance, Festinger, Schachter and Back took into account only the proxemic relations in the housing project. They did not take into account the relations the respondents' husbands had as students and employees during the many hours a day they were not at home. During apprenticeship training only two such sets of relations were fixed by assignment and occupied for considerable periods of time each day: compartment rack order and classroom desk order.

In designing the study, I considered whether these orderings should be different or as alike as possible. The effect of very different orderings was interesting. There is little attention in the literature to sequential, multiple orderings. This would have constituted an additional experimental condition impossible to accomodate within the overall design since it would have resulted in too many groups. I decided that while it was impossible to maintain classroom ordering equivalent to that in the compartment we should seek to maintain it as closely as possible. Since informal observation indicated covert interaction occured mostly within rather than between rows the ordering was maintained within rows. A typical ordering is displayed in Figure 13. Rows were numbered from left to right (facing the front of the classroom). Subject 1 was assigned to the front seat in Row 1, subject 2 to the seat behind, and so on. The next row was filled from the back so that the next numbered subject after the last in Row 1 was directly across the isle in Row 2.

Because our primary focus was on informal, spontaneous interaction it was necessary to observe apprentices very carefully in the classroom. For the most part their training consisted of six to eight hours of lectures per day. They were forbidden to talk to each other during lectures.

Figure 13:

A Typical Classroom Desk Ordering
by Subject Number



Communication was covert and fleeting, often whispered exchanges during lectures or tests. Since communication was covert it was difficult to code if the entire class was monitored at one time. Again, we decided to sample, this time by rows. The observer was given a randomly ordered list of rows (without replacement). He would observe the first row in the ordering for five minutes, then the next, and so on. When all the rows had been observed he would start again using another ordering. The observer sat at the back of the classroom to make these observations.

Students were ordered to stand in the back of the classroom if they thought they might go to sleep in class. It was not unusual at any particular time for several students to be standing. If a student(s) from the row being observed was standing in the back then he was included in that sample.

THE CLASSROOM LOUNGE

Periodically, but at irregular intervals, a class was given a smoke break. Apprentices went to a large room in which there were four high narrow benches on which ashtrays were located. Rules about throwing ashes or cigarettes on the floor were very strict so they clustered around these benches to talk and smoke. There were no chairs. During short breaks observers coded these clusters distinguishing separate conversation groups within them when such differentiation was possible. They did not code interaction but rather the apparent physical clustering of the subjects into interacting groups. Since this clustering was by choice, I thought it might give some clue to informal relations.

GALLEY SAMPLING

The base was served by a very large galley. Since nearly two thousand sailors had to be fed at each meal, scheduling was rigid. Each unit was scheduled for a particular time. The unit marched to the galley, went through a cafeteria line, and then individuals seated themselves at separate four to six man tables of their own choice. Their freedom to choose was constrained only by the number of tables already occupied.

Because I thought the sharing of meals might also provide a clue to the development of informal relations observers accompanied the unit to the galley. After it had passed through the cafeteria line and individuals had chosen their tables, the observer circulated through the galley coding the subjects by table. He made no attempt to count interactions but only to specify table groups.

LIBERTY SECTIONS

Each unit was divided into two liberty sections. On alternate days each section was on liberty from 1830 until 2130. The entire unit was together in the compartment from 1530 to 1830 and then only one section was in the compartment from 1830 to 2130, except for those who were eligible for liberty but chose to remain in the compartment. Some evenings, for disciplinary reasons, liberty was cancelled. While it was impossible to observe the group on liberty, it was possible to know which subjects they were and, to some extent, which subjects went together. Every subject who went on liberty was noted on a liberty list by the company clerk and his exact time of return was logged. This liberty list was copied at the end of each day. A fairly strong assumption was made that if subjects A, B and C all returned at exactly the same time that they had been on liberty together.

Interaction was not frequent in the classroom. From classroom lounge, galley and liberty list only grouping could be inferred. For none of these were frequencies large. Therefore, these data have only been used to supplement the interaction data gathered in the compartment.

MECHANICS OF DATA COLLECTION

This design proved practical for the Navy project. Subjects were contacted when they reported for training. The project was explained to them and their informed consent obtained. If they gave their consent to be part of the study, we sought their permission to take a polaroid snapshot. The photo was labelled with the subject's project identification number and name. This served as a learning tool for observers who also spent from one to three days with the subjects before the unit was officially formed and began training. In this way the 30 to 50 subjects were individually known to the observers by number and name before the formal data collection began.

During the approximately 14 days each unit was observed, data were recorded by both machine and pencil and paper techniques. A prototype, solid state Datamyte II was used during most of the study (see Figures 14-15). This device, which contains an automatic clock, has a keyboard which permits entry of numeric or alphabetic codes. These are stored, together with the times, in the device. At the end of the observation period the memory was emptied directly onto magnetic tape on a computer 400 miles away through an Execuport portable teletype terminal. The data were cleaned on line. The paper and pencil data were a backup in case of failure of the Datamyte II. Figure 11 is an example, not only of the observer code, but of Datamyte II output.

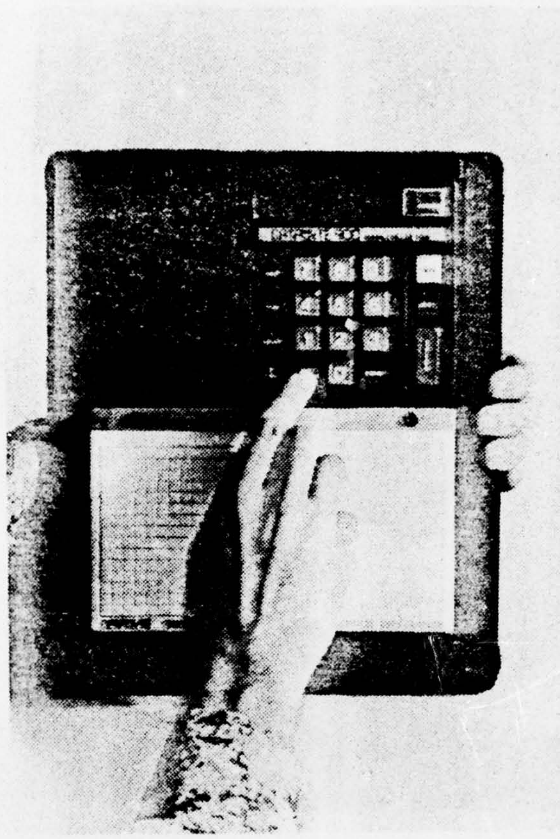


Figure 14: The Datamyte keyboard. It is rather like using a portable calculator.

Figure 15: This is the normal way to hold the Datamyte while in use. It is lightweight and easily grasped with one hand.

THE CODE

To record their data observers used an alphanumeric observational language which was recorded onto the memory of the Datamyte II through its keyboard. Various combinations of letters and numbers were the vocabulary of the observational language. Each "word" in the language was constrained by certain ordering rules, somewhat like a grammar, as well as by other conventions.

	Word	Meaning	Explanation
1.	HHH,	Beginning of observer work day.	The observations were made over several hours each day. Beginning and end of day codes marked the boundaries of the entire day's data.
	mmddyy,	Date.	Month, day and year the data were collected.
	tttt,	Time.	Datamyte II contains a clock counting in hundredths of minutes. To relate this to a regular 24-hour clock as used in the military it was necessary to enter the time of day by hand.
2.	CFH,	Beginning of observation cycle.	In each sampling location (compartment, classroom, classroom lounge, galley) each complete cycle of samples had to be preceded by this indicator.
	tttt,	Time	Time cycle began on 24-hour clock.
3.	on*sn*ln,	Observer number, sample number, location number.	Every observer was given a number. Each sample cycle was assigned a unique number (1...n) from the start of each unit. Compartment, classroom, lounge and galley were also assigned numbers.
4.	Cnn,	Sample area number within sample cycle.	For area numbers within the compartment see Figure 10.
	Fnn,	Subject(s) physically present - no interaction.	Every subject physically present but not interacting in the sampling area was coded by number.

Word	Meaning	Explanation
Hnn, nn,	Subjects interacting.	One group of subjects interacting follows any H.
Hnn,nn,	Another group interacting	Often more than one group may be located in the same area. Every numbered subject within the group follows the H.
Cnn,	Sample area number.	The next area in the randomly ordered list of areas in the cycle.
etc.		
5. CCC,	End of observation cycle.	After the ten areas are sampled a cycle is complete.
tttt,	Time.	Time cycle ended on 24-hour clock.
6. HFC,	Liberty list.	After sailors return from liberty they sign in with the times of their return recorded beside their names. For clues to leisure companions this list was recorded by subject number and time.
nn*tttt,	Subject number and time returned from liberty.	
HFC, HFC,	End of liberty list.	
7. ***,	End of observer's work day.	This must appear at the finish of each day's data collection.
mmddyy,	Date.	
tttt,	Time.	

Specific Indicators

1n	Compartment - 21; Galley - 22; classroom - 23; classroom lounge - 24
F100	Sample area empty.
85	Non-unit apprentice (repeat as needed)
86	Navy person (not apprentice); i.e., unit counselor, instructor, etc.
99	Group as-a-whole.

Appendix 3.1

DETERMINING SAMPLE SIZE NECESSARY TO DETECT GROUPS FROM INTERACTION FREQUENCIES

by

Kinley Larntz, Ph.D.

INTRODUCTION

One objective of a study in which frequencies of dyad interactions are collected is to identify groups (i.e., cliques) that exist in the study sample. A group is defined here as a collection of individuals that interact at a rate higher than that usually expected for a random collection of individuals. Of course, the ability to identify groups will depend heavily upon how far above the norm the group interaction rate turns out to be, e.g., a group that interacts at ten times the normal rate is much easier to detect than one that interacts at ten percent above the normal rate.

In designing an experiment one of the principal questions a researcher must address is whether the study has a chance of accomplishing its objectives. If the identification of groups is an objective, then it is important to determine what constitutes an adequate sample size (i.e., how many observations are needed) for such identification. This report addresses the question of required sample size when groups interact at a rate of k (k>1) times the normal rate.

NOTATION AND ASSUMPTIONS

The study sample consists of N individuals all of whom are free to interact with the others. The random pairing interaction model assumes that pairs of interacting individuals are formed at random but allows for differing propensities to interact ($\Pi_1, \Pi_2, \cdots, \Pi_N$). For the pair (i,j) the relative frequency of interaction under the random pairing model is

$$P_{ij} = \frac{\Pi_i \Pi_j}{\sum\limits_{i<j} \Pi_i \Pi_j} .$$

If n interactions are observed the expected number of (i, j) pairs is simply

$$\tilde{m}_{ij} = nP_{ij}$$

For details on estimation of the $\tilde{m}_{ij}$ under the random pairing model, see Larntz and Weisberg (1976).

The data available for analysis will usually consist of the frequencies of pair (i, j) interaction which we will label X_{ij}. Thus $\sum_{i<j} X_{ij} = n$ is the total number of observations. Since observation usually occurs for a fixed length of time (rather than until n counts are recorded), a reasonable model for the counts X_{ij} is that they are independent random variables following a Poisson distribution, $X_{ij} \sim$ *Poisson* (m_{ij}). The objective of identifying groups is translated into identifying pairs whose Poisson rate m_{ij} is higher than the rate under random pairing, namely $\tilde{m}_{ij}$.

A normal approximation for the distribution of X_{ij} is possible when m_{ij} is large. Small sample improvements have been proposed by many individuals, but one that has proven particularly useful is due to Freeman and Tukey (1950),

$$d_{ij} = \sqrt{X_{ij}} + \sqrt{X_{ij} + 1} - \sqrt{4m_{ij} + 1} \approx N(0,1).$$

For the calculation of sample sizes this is replaced by the asymptotically equivalent $2\left[\sqrt{X_{ij}} - \sqrt{m_{ij}}\right] \approx N(0,1)$.

However, in practice the group determinations are based on the Freeman-Tukey approximation.

Calculation of Required Sample Size

If there are N individuals in the study sample, there will be $\binom{N}{2}$ possible pairs, and thus when .05 level tests are conducted on each pair the overall error rate becomes much greater than .05. To adjust for this problem, a common procedure calls for making the individual tests at a reduced significance level,

$$\alpha^* = \frac{\alpha}{\binom{N}{2}}$$

The overall error is then bounded above by α. Thus, "significant" pairs will be identified by Freeman-Tukey deviates in excess of γ_{α^*}, where γ_{α^*} is the one-tailed α^* critical value for the normal distribution. Values of γ_{α^*} for N = 20, 40, 75 are given in the table below:

Adjusted Normal Critical Values

N	Number of Pairs	α = .10	α = .10	α = .10
20	190	3.28	3.47	3.88
40	780	3.66	3.83	4.21
75	2775	3.97	4.13	4.49

To calculate the required sample size for a given situation, the alternative hypothesis and the power requirement must be specified. To illustrate the calculations we will use N = 40, α = .05, required power of .90, and an alternative rate that is k = 3 times the random pairing rate. The form that the sample size requirement takes is calculation of $\tilde{m}_{ij}$. Thus, under the null hypothesis (random pairing) X_{ij} will have rate $\tilde{m}_{ij}$ while under the alternative the

rate will be $k\tilde{m}_{ij}$. Using the normal approximation makes the power calculations easier since the requirement becomes one of finding $\tilde{m}'_{ij}$ to satisfy

$$P_r\left[\sqrt{X_{ij}} \geqslant \sqrt{\tilde{m}_{ij}} + .5\,\gamma_{\alpha^*} \;\middle|\; E\,(X_{ij}) = k\tilde{m}_{ij}\right] = \begin{matrix}\text{Required}\\ \text{Power}\end{matrix}$$

If γ_{1-p} is the normal one-tailed critical value for a test at level 1-p, then m_{ij} will be given by

$$\sqrt{k\tilde{m}_{ij}} - \sqrt{\tilde{m}_{ij}} - .5\,\gamma_{\alpha^*} = .5\,\gamma_{1-p}$$

or

$$\tilde{m}_{ij} = \left[\frac{.5\,(\gamma_{1-p} + \gamma_{\alpha^*})}{\sqrt{k} - 1}\right]^2$$

For the example case,

$$\tilde{m}_{ij} = \left[\frac{.5\,(1.28 + 3.83)}{\sqrt{3} - 1}\right]^2 = 12.18$$

Thus, if the random pairing model has expected value 12.18 in the (i,j) cell and the true rate of interaction is 36.54 we will have a 90% chance of detecting the increased rate at level $\alpha = .05$.

Tables of required $\tilde{m}_{ij}$ are given for N = 20, 40, 75; α = .10, .05, .01; k = 2, 3, 4, 5, 7, 10; and required power .50, .75, .90, .95, .99. The value computed above appears as the table value for N = 40, α = .05, k = 3, power = .90.

All of the computations are based on the normal approximation which is better for larger values of $\sqrt{k\tilde{m}_{ij}}$ than for small values. Thus, for very small values of $\sqrt{k\tilde{m}_{ij}}$, such as less than 5, the power requirement may not be attained exactly.

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Multiplicative models for dyad interaction. To appear in

Journal of the American Statistical Association, 71, June 1976.

N = 20	Size of Test	Power .50	.75	.90	.95	.99
k = 2	.10	15.7	22.8	30.3	35.3	45.9
	.05	17.5	25.1	32.9	38.1	49.0
	.01	21.9	30.3	38.8	44.5	56.2

		.50	.75	.90	.95	.99
k = 3	.10	5.02	7.32	9.70	11.3	14.7
	.05	5.62	8.03	10.5	12.2	15.7
	.01	7.02	9.70	12.4	14.2	18.0

		.50	.75	.90	.95	.99
k = 4	.10	2.69	3.92	5.20	6.60	7.87
	.05	3.01	4.31	5.64	6.54	8.41
	.01	3.76	5.20	6.66	7.63	9.64

		.50	.75	.90	.95	.99
k = 5	.10	1.76	2.57	3.40	3.97	5.15
	.05	1.97	2.82	3.69	4.28	5.50
	.01	2.46	3.40	4.36	4.99	6.31

		.50	.75	.90	.95	.99
k = 7	.10	0.99	1.45	1.92	2.24	2.90
	.05	1.11	1.59	2.08	2.41	3.11
	.01	1.39	1.92	2.46	2.82	3.56

		.50	.75	.90	.95	.99
k = 10	.10	0.58	0.84	1.11	1.30	1.68
	.05	0.64	0.92	1.21	1.40	1.80
	.01	0.80	1.11	1.42	1.63	2.06

NOTE: Tabled value is the cell expectation ($\tilde{m}_{ij}$) required under the random pairing model to detect a rate of $k\tilde{m}_{ij}$.

Power

N = 40	Size of Test	.50	.75	.90	.95	.99
	.10	19.5	27.4	35.6	41.0	52.3
k = 2	.05	21.4	29.6	38.0	43.7	55.3
	.01	25.8	34.8	43.9	50.0	62.3

		.50	.75	.90	.95	.99
	.10	6.25	8.79	11.4	13.1	16.7
k = 3	.05	6.84	9.49	12.2	14.0	17.7
	.01	8.27	11.2	14.1	16.0	20.0

		.50	.75	.90	.95	.99
	.10	3.34	4.71	6.10	7.04	8.97
k = 4	.05	3.67	5.09	6.53	7.49	9.49
	.01	4.43	5.98	7.54	8.57	10.7

		.50	.75	.90	.95	.99
	.10	2.19	3.08	3.99	4.60	5.87
k = 5	.05	2.40	3.33	4.27	4.90	6.21
	.01	2.90	3.91	4.93	5.61	7.00

		.50	.75	.90	.95	.99
	.10	1.24	1.74	2.25	2.60	3.31
k = 7	.05	1.35	1.88	2.41	2.77	3.50
	.01	1.64	2.21	2.78	3.16	3.95

		.50	.75	.90	.95	.99
	.10	0.72	1.01	1.30	1.50	1.92
k = 10	.05	0.78	1.09	1.40	1.60	2.03
	.01	0.95	1.28	1.61	1.83	2.29

NOTE: See Note on Page 7.

Power

N = 75	Size of Test	.50	.75	.90	.95	.99
k = 2	.10	23.0	31.5	40.2	45.9	57.8
	.05	24.9	33.7	42.6	48.6	60.8
	.01	29.4	38.9	48.5	54.8	67.8

		.50	.75	.90	.95	.99
k = 3	.10	7.4	10.1	12.9	14.7	18.5
	.05	8.0	10.8	13.7	15.6	19.5
	.01	9.4	12.5	15.5	17.6	21.7

		.50	.75	.90	.95	.99
k = 4	.10	3.9	5.4	6.9	7.9	9.9
	.05	4.3	5.8	7.3	8.3	10.4
	.01	5.0	6.7	8.3	9.4	11.6

		.50	.75	.90	.95	.99
k = 5	.10	2.6	3.5	4.5	5.2	6.5
	.05	2.8	3.8	4.8	5.5	6.8
	.01	3.3	4.4	5.4	6.2	7.6

		.50	.75	.90	.95	.99
k = 7	.10	1.45	2.0	2.5	2.9	3.7
	.05	1.57	2.1	2.7	3.1	3.9
	.01	1.86	2.5	3.1	3.5	4.3

		.50	.75	.90	.95	.99
k = 10	.10	0.84	1.16	1.47	1.69	2.1
	.05	0.91	1.24	1.56	1.78	2.2
	.01	1.08	1.43	1.78	2.0	2.5

NOTE: See Note on Page 7.

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LIST 4

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